Electrostatic Levitation for Studies of Additive Manufactured Materials

National Aeronautics and Space Administration

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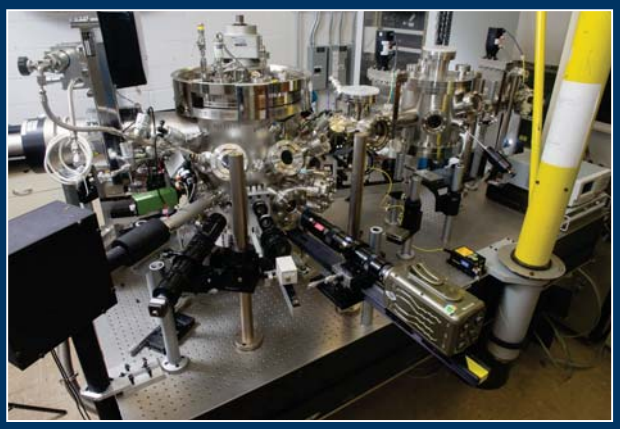
The NASA Marshall Space Flight Center (MSFC) Electrostatic Levitator (ESL) Laboratory is a unique facility for investigators studying high-temperature materials. The laboratory has two levitators in which samples can be levitated, heated, melted, undercooled, and resolidified, all without the interference of a container or data-gathering instrument.

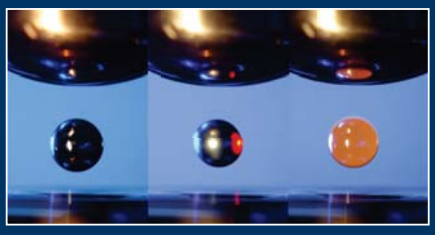
The ESL lab can provide measurement of thermophysical properties, which include surface tension, viscosity, creep strength, density, emissivity, and phase diagrams. The lab also has the ability to measure and control the oxygen partial pressure within the chamber.

Modeling of additive manufacturing materials processing is necessary for the study of their resulting materials properties. In addition, the modeling of the selective laser melting processes and its materials property predictions are also underway. Unfortunately, there is very little data for the properties of these materials, especially of the materials in the liquid state. Some method to measure thermophysical properties of additive manufacturing materials is necessary.

The ESL lab is ideal for these studies. The lab can provide surface tension and viscosity of molten materials, density measurements, emissivity measurements, and even creep strength measurements. The ESL lab can also determine melting temperature, surface temperatures, and phase transition temperatures of additive manufactured materials.



NASA Marshall Space Flight Center (MSFC) Electrostatic Levitator (ESL) main chamber.



A levitated 2-mm (0.08-in.) diameter sample of titanium-zirconium-nickel (Ti-Zr-Ni) in the ESL. This figure shows the sample levitated, heated, and then melted.

High-Temperature Emissivity Measurement System (HiTEMS). The lab also has an emissometer, which can provide normal spectral emissivity and normal total emissivity at temperature (600 °C to 2700 °C).

Magnetic rotator supporting creep investigations. The lab has the ability to spin the sample at a specific rotation rate, as high as 30,000 Hz, to cause creep deformation due to the centripetal acceleration.

Research Programs

Thermophysical Properties
- Emissivity
- Surface tension
- Viscosity
- Density
- Undercooling
- Creep

Solidification
- Nucleation temperature and rate
- Solidification velocity

Other
- Phase behavior/equilibrium
- Time-temperature-transformation diagram
- Metastable phase transformation